Comment on
"Measurement of the $\pi^+\vec{p}$ analyzing power at 68.3 MeV"

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Abstract

We comment on a recent paper by Weiser et al. [Phys. Rev. C **54**, 1930 (1996)]. The authors have performed a single-energy analysis of π^+p scattering data at 68.3 MeV, finding a value for the S_{31} phase shift about 1° smaller than found in the Karlsruhe-Helsinki (KH) partial-wave analysis. The authors use this result to argue for a dispersion relation analysis using recently measured data, so that their effect on the πNN coupling constant (f^2) and Σ amplitude can be determined. We note that these tasks were accomplished prior to the submission of the above paper. We clarify the effect of this new analyzing power data on f^2 and the Σ amplitude.

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The authors of Ref. [1] have used their new measurement of the $\pi^+\vec{p}$ analyzing power at 68.3 MeV in a determination of the S31 phase shift. The result is a value about one degree smaller than that found in the KH analysis [2]. Given this discrepancy, the authors suggest the need for an alternative dispersion analysis of πN scattering data to determine the Σ amplitude and f^2.

The Σ amplitude can be determined by extrapolating the $A^{(+)}$ amplitude [2] to the Cheng-Dashen point ($\nu = 0$, $t = 2\mu^2$). A reliable extrapolation requires a precise determination of $A^{(+)}$ at low energies. This motivated the low-energy measurements of Ref. [1]. The effect of low-energy data on f^2 can be seen from the Goldberger-Miyazawa-Oehme (GMO) sum rule [3], which relates the S-wave scattering lengths to f^2 and an integral over total cross sections.

In this Comment, we describe the effect of the new analyzing power data [1], on the Σ amplitude and f^2. These questions have already been considered by Arndt *et al.* [4,5] and indirectly by Sainio [6]. In the analyses of Arndt [5], the result $\Sigma \approx 68$ MeV was found. Sainio [6], using the solutions KH80 [2] and SM95 [4], gave a range ($\Sigma = 60 \pm 10$ MeV) consistent with our estimate. (The SM95 analysis and its associated single-energy analyses utilized the data of Ref. [1].) Values for f^2 were also determined [5] using solution SM95. The range of values ($f^2 = 0.076 \pm 0.001$) was found to lie within the range ($f^2 = 0.076 \pm 0.003$) quoted in Ref. [1].

In Table I, we compare the phase shifts and χ^2 values from a number of analyses [2,4,7–9]. The renormalization factor is also given for each of the two data sets (Set I containing 3 points and Set II containing 4). (Note that this is the factor which should be applied to the analysis when it is compared to the data.) In all cases, the analyses are renormalized downward to fit the data. Again, in all cases, the data of Set II are in better agreement with the analyses.

As should be expected, the single-energy analysis [7] (C6) has the lowest χ^2. Here the renormalization factor is near unity. In fact, the phase shifts found in Ref. [1] almost perfectly reproduce our results. However, when the data of Ref. [1] were included in an

energy-dependent analysis, more renormalization was necessary. This in turn resulted in an S31 phase which was closer to the KH result. The S31 phase found in solution SM90 [8] (prior to the measurement of Ref. [1] and prior to the addition of dispersion relation constraints) is not very different from SM95 [4] (which included the preliminary data of Ref. [1] and applied a range of dispersion relation constraints).

Finally, in Table II of Ref. [1], the authors claim that the KH analysis gives a χ^2 of 116.54 against the 7 analyzing power data. This very high χ^2 results if the systematic error ($\pm 5\%$) is neglected. When the systematic error is taken into account, the χ^2 drops by more than a factor of 5.

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Table I. Fits of partial-wave analyses to the analyzing power data of Ref. [1]. Results for the S31, P31, and P33 partial-waves are given. Types of analysis are: DR (utilizing dispersion relation constraints), ED (energy-dependent with no dispersion relation constraints), and SE (single-energy). A predicted renormalization factor (see text) is also given in each case for the two separate data sets.

PWA	Type	S31	P31	P33	χ^2/datum	(Norm I, Norm II)
KH80 [2]	DR	-6.96	-1.23	10.12	21.3/7	(0.86, 0.87)
KA84 [9]	DR	-6.96	-1.27	10.08	21.8/7	(0.85, 0.87)
SM90 [8]	ED	-6.54	-1.12	9.99	10.1/7	(0.91, 0.93)
SM95 [4]	DR	-6.43	-1.23	9.94	8.3/7	(0.92, 0.94)
C6 [7]	SE	-6.08	-1.23	9.65	4.3/7	(0.96, 0.99)